International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)
ISSN (P): 2249–6890; ISSN (E): 2249–8001
Vol. 9, Issue 5, Oct 2019, 885–898

Original Article

COMPARISON OF THE PHYSICAL AND MECHANICAL PROPERTIES OF COMPOSITE MATERIALS (AL2024/BORON FIBER COARSE PARTICLES AND AL2024/ BORON FIBER FINE PARTICLES) PRODUCED BY POWDER METALLURGY TECHNOLOGY

R. RAMANJANEYULU[1*], K. RAJA GOPAL[2] & B. DURGA PRASAD[3]

[1]*Research Scholar, Department of Mechanical Engineering, JNTUA, Ananthapuramu, Andhra Pradesh, India*

[2]*Professor, Department of Mechanical Engineering, KSRMCE (Autonomous), Kadapa, Andhra Pradesh, India*

[3]*Professor, Department of Mechanical Engineering, Jawaharlal Nehru Technological University Anantapur, Andhra Pradesh, India*

ABSTRACT

In this examination, metal matrix composites (MMCs) were fabricated utilizing powder metallurgy method. Powder metallurgy deals with products and procedures, which utilize raw material as powders that are compacted into the required shape and size utilizing suitable molds. These compacted powders are called Green compacts. The properties of the component delivered by powder metallurgy procedures are impacted by powder characteristics, for example, composition, morphology, particle size, distribution and method of compaction. The initial phase in the powder metallurgy procedure is the arrangement of green compacts. Uniaxial pressing is one of the most broadly utilized compaction techniques for the preparation of green compacts. Aluminum 2024 is reinforced with different sizes of boron fiber particles (i.e. fine and coarse particles) with volume portions as (5, 10 and 15 wt. %). The most significant utilization of aluminum is with boron fiber coarse particles and aluminium with boron fiber fine particles reinforcement of aluminum metal matrix and so on. The samples were prepared by using aluminum alloy powder with 50µm in particle size with reinforced of boron fiber (fine and coarse) particles sizes are50µm and 125µm in, respectively. The picked powders were blended by using a ceramic bowl and stirrer mixing set up at conventionally, in the wake of the blending process, the powders were compacted by utilizing an UTM (Krystal Engg, UTK-40) at 3.6 ton and 12.5 tons as indicated by (ASTM-E8). At long last, the green compacts were sintered at 460^{0}C-470^{0}C for 7 hr. by utilizing an electrical heater with an argon air. There are numerous assessments and tests, accomplished for the created (AL2024/Boron fiber coarse particles and AL2024/Boron fiber fine particles) of the metal matrix composites. The consequences of this examination demonstrated that improving the physical properties (green density, sintered density and densification density) and mechanical properties

KEYWORDS: Metal Matrix Composite Materials, Powder Metallurgy Method, AL2024/Boron Fiber Coarse Particles & AL2024/Boron Fiber Fine Particles

Received: Jul 04, 2019; **Accepted**: Jul 24, 2019; **Published**: Sep 24, 2019; **Paper Id.**: IJMPERDOCT201978

1. INTRODUCTION

Starting late, a noteworthy asks about what done to improve the mechanical properties of aluminium compounds by reinforcing them with ceramic production particles, for Ex, Sic, B_4C, Tic and Al_2O_3(Zhenga et al., 2014), since aluminum and its compounds have been considered as a critical metal to get metal matrix composites (MMCS) and have more applications in development. To solidify the lightweight, corrosion resistance with mechanical

properties, for ex, the quality, hardness and impact of effect protection from make the aluminum and its alloys, huge of the matrix materials (Muthukrishnan et al., 2008, Khairaldien et al., 2007 and Ahmed et al., 2009).

There are various reinforcement materials used for aluminum matrix, in perspective on their quality associated with their particle size, the microstructure and how they are distributed in the matrix, which in this way improving the mechanical and physical properties of the making of aluminum matrix composites (Attar et al., 2015). Powder metallurgy is a huge system used to get metal matrix composites with high homogeneity more than for various techniques (Nazik et al., 2016). Powder metallurgy (P/M) is one of the techniques, effectively utilized for the planning of MMCs (Suryanarayana, 2001). The principle bit of leeway of P/M over different strategies, for example, ingot metallurgy and dispersion welding, is the moderately low handling temperature, which may stay away from undesired interfacial responses between the reinforcement and the matrix (Erich, 1986). There are various inspects circulated in this field (Ekiki et al., 2010), who inquired about the effect of Sic and B4C on the qualities of the surface for the composites material. This assessment deduced that there are various segments impacted on the conveyed composites materials, for instance, particle size, and volume division of the additional substance reinforced material (Nagard et al., 2013), while examining the effect of the extension of Al2O3 on the mechanical and wear lead of the composites materials of 6061 Al combination metal matrix composites. The results of this work exhibited that the wear resistance of B4C is lower than that of Sic particulate reinforcement of metal matrix composites (MMCS). The purpose of this work is to consider the physical and mechanical properties of metal matrix composites reinforced by two various particulate reinforced materials Sic and B4C for the framework Al–6061 compound.(Kwon et al., 2001) examined the densification conduct of different double systems during sintering and discovered that densification characteristics strongly depends on the concentration of the element. (Wang et.al., 2007) inspected the impacts of powder type and compaction weight on the density conduct of two kinds of Hoganas iron powders, and those components are having a significant effect on porosity, green density and sintered density of the last powder metallurgy compacts. In the detailed writing survey, it is discovered that the adequacy of the powder metallurgy item relies upon its density and miniaturized scale constituents. Hence, in this exploration work, an exploratory examination on the densification conduct on the creation of AZ91D/fly ash powder metallurgy was performed. Compacts of different volume portion of fly powder 0%, 5%, 10%, 15%, with two distinct loads 15 ton and 25 ton were utilized to manufacture the compacts.

2. EXPERIMENTAL PROCEDURE

In this work, the composite materials, i.e. AL2024 alloy with reinforced materials of the boron fiber (coarse and fine) particles are produced by Powder metallurgy technology as the following steps.

2.1 Making the Powders

The aluminum 2024 alloy particle size is 50µm, while the particulate reinforcement of boron fiber, fine particles and boron fiber coarse particles at 50µm and 125µm in size, respectively given in the table1

Table 1: Characteristics of the Powders, (Callister and JR, 2003)

Sl. No	Powder	Particle Size (µm)	Density (gm/cm3)
1	Al 2024 alloy	50	2.78
2	Boron fiber coarse particles	125	2.57
3	Boron fiber fine particles	50	2.34

Table 2: Chemical Composition of Al 2024/BC (Boron Fiber Coarse Particles) Ratio

Al 2024(%)	Boron Fiber Coarse Particles (%)	Total (%)
100	0	100
95	5	100
90	10	100
85	15	100

2.2 Mixing the Powders

Various particle sizes of reinforced composite materials were produced by blending the AL 2024alloy Powder, as a matrix at 50µm in the powder particle size with boron fiber coarse particles and boron fiber, fine particles as a reinforcement material at 125µm and 50µm in the powder particle size, and adding bonding material as an activator. Mixing process was carried out the powders of Aluminum 2024 alloy with boron fiber coarse particles (BC) and boron fiber Fine particles (BF) were mixed in a ceramic mortar with pestle uniformed.

2.3 Compacting Process

The powders of Aluminum 2024 and Boron fiber coarse particles and Boron fiber, fine particles were mixed in a ceramic mortar with pestle uniformed. The amount of 15gm mix powder utilized for compacting process. The blend was compressed in dies on a universal testing machine at a pressure of 256 mpa to get the samples of size 25 mm diameters. And afterward, the blended powders were squeezed at 256 Maps (12.5 ton) in punch die set, set together as appeared in Figure.2. In die wall and the outside of punch contact with the pass on were lubricated, and oiled up with graphite powder to keep the green compacts from bond with die wall and don't crush during get out the die. The green compacts were weighed by exactness balance to calculate the density of them. The purpose of the compacting is to consolidate the powder into the desired shape and as closely as possible to final dimensions; it is designed to impart the desired level and type of porosity and to provide adequate strength for hardening. Compacting was done in UTM (Universal Testing Machine) as shown in the Figure 2. The various compacting loads 125KN or 12.5 tons or 255 Maps were used for compaction.

Table 3: Chemical Composition of Al 2024/BF (Boron Fiber Fine Particles) Ratio

Al 2024(%)	Boron Fiber Fine Particles (%)	Total (%)
100	0	100
95	5	100
90	10	100
85	15	100

Figure 1: Ceramic Mortar with Pestle.

Figure 2: Compacting was done in UTM (Universal Testing Machine).

2.4 Sintering Process

Samples were sintered at elevated temperature of 440°C in a muffle furnace for 6 hours and the samples were allowed to cool in the furnace itself for 14 hours. Sintering process was done at 460°C–480°C for 6 hours. In electrical warmer with idle climate (argon), sintering temperature increases with extending the degree of particulate reinforcement to get the composites with high strength.

$$\text{i.e., Density} = \frac{\text{Weight of the specimen}}{\text{Volume of the specimen}}$$

Conventional sintering has also been done using a tube furnace at a temperature of 460°C–480°C for 360 mints in argon gas environment to avoid oxidation.

2.5 Examination and Tests

2.5.1 Microstructure Examination (Using SEM)

Microstructure examination of the AL2024 alloy with Boron fiber coarse particles and AL2024 alloy with Boron fiber, fine particles of metal matrix composites were examined by utilizing optical microscopy, before the examination of the microstructure, The samples were machined by using lathe machine, and afterwards grinding with various grades of emery paper are used, and also the samples were polished by disc polishing machine by utilizing alumina paste at size 0.7µm for 15 min to acquire surfaces like a mirror. Finally, the composite samples is etching them with prepared solution and apply surface of the samples for 10sec, all these processes is done before the examination for the microstructure.

Figure 3: Muffle Furnace.

Figure 4: Sintered Samples.

Figure 5: Scanning Electronic Microscopy (SEM).

2.5.2 Density Test

Density test was done for the sample when sintering. The differences of density values mean that, there is porosity in the samples. The porosity of the samples when sintering was determined by utilizing the Archimedes principle. The theoretical densities of metal matrix composites are estimated by using equations (Venkatesh et al., 2015). For aluminium with silicon carbide, for aluminum with boron carbide, the actual density after the sintering was determined by using the equation (Jain et al., 2016). The porosity of the sample was determined by using the given equation

Density and Void Content Measurement

The green density and sintered density of the fabricated composites were measured using the Archimedes principle. Theoretical densities were calculated using the following theoretical density equation used (Siddhartha Tiwari et al., 2012). Void content was measured using void content equation used (Rohatgi Prasanta et al., 2006). Table 4 shows the data obtained from experiments.

$$\text{Theoretical density of BC} = \frac{(\text{Density of AL2024 x \% of AL2024}) + (\text{Density of BC particles x \% BC particles})}{100}$$

$$\text{Theoretical density BF} = \frac{(\text{Density of AL2024 x \% of AL2024}) + (\text{Density of BF particles x \% BF particles})}{100}$$

$$\text{Void content} = \frac{\text{Theoretical density - Measured density}}{\text{Theoretical density}}$$

$$\text{\% Densification} = \frac{\text{Density of the sample}}{\text{Theoretical density x 100}}$$

Figure 6: Experimental Density Test by Archimedes Principle.

Figure 7: Rockwell Hardness Test.

2.5.3 Hardness Test

Hardness test was done for the samples when sintering, by utilizing Rockwell hardness machine (Wilson Hardness machine, USA Model: LM 2481 T). Softer materials are tried on the B scale with 1.6mm distance across steel ball and 90kg significant burden. A minor heap of 10kg is first connected, the profundity of space on a dial check assistants of hardness number. Composites Specimen were tried by utilizing (B) size of Rockwell machine with hardened steel ball, as an indenter of 100 Kg were utilized for every one of the samples. For every sample, three readings were taken in any event, and after that decided the normal of the three readings.

3. RESULTS AND DISCUSIONS

3.1 Microstructure Analysis

The morphology of the sintered MMC's was analyzed by utilizing optical microscopy. Boron fiber coarse(BC) and Boron fiber fine (BF) particulates were agglomerated in little volume segments of them, while extending the volume divisions of BC and BF lead to making the particles, to disperse homogeneously in aluminum matrix, and strong bonding was made between the particulate reinforcement material and matrix, as showed up in figure.8.

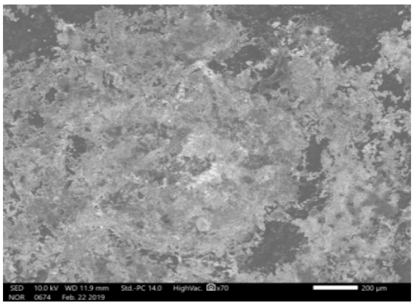
3.2 Density

A Weight % of Boron Fiber Coarse Particles and Boron Fiber Fine Particles with Theoretical Density and Experimental Density

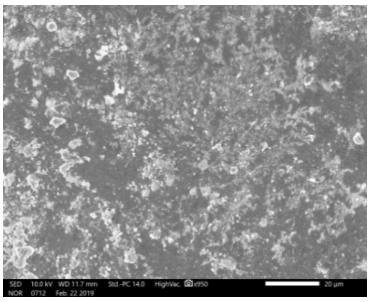
Theoretical density and experimental density of the composite material decreases with increasing the percentage of boron fiber coarse particles and boron fiber fine particles; this is due to the material of reinforcement, because boron fiber coarse particles and boron fiber fine particles contains various sizes and shape of the particles. Figure 9 shows the relation between percentages of boron fiber coarse particles and boron fiber fine particles with theoretical and experimental density**.**

B Weight % of Boron Fiber Coarse Particles and Boron Fiber Fine Particles with Green Density

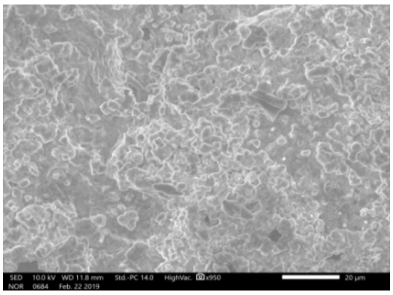
Pure aluminium alloy has high density than the composites, because boron fiber addition decreased the density of aluminium alloy. From Figure 11, it is identified that the composites fabricated using 12.5 ton load have better density when compared to 5 ton load applied composites, this is due to more load, which allows the void closing during compaction.



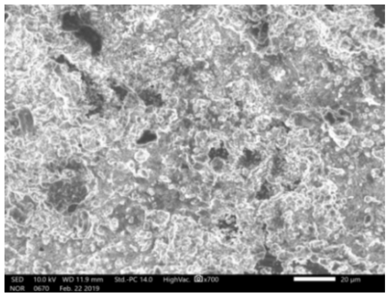
Without Boron Fine Particles.



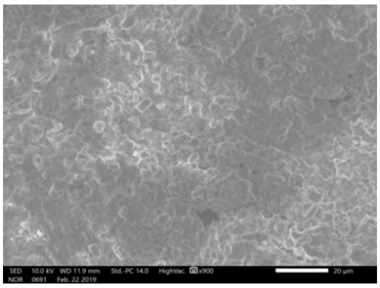
5% of Boron Fiber Coarse Particle.



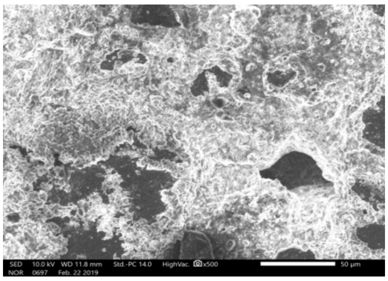
10% of Boron Fiber Coarse Particle.



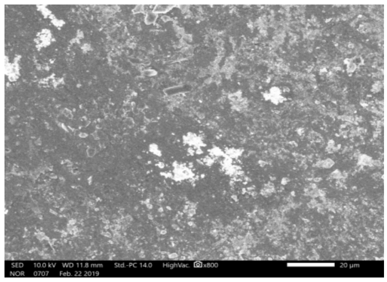
15% of Boron Fiber Coarse Particle.



5% of Boron Fiber Fine Particle.



10% of Boron Fiber Fine Particle.



15% of Boron Fiber Fine Particle.

Figure 8: Showed that the Micrographs of the Specimens adding Boron Fiber Coarse Particles and Boron Fiber Fine Particles with Different Weight Frictions.

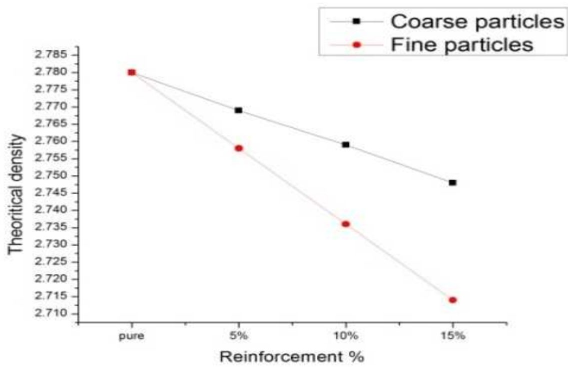


Figure 9: Showed the Theoretical Density of the Metal Matrix Composite Materials.

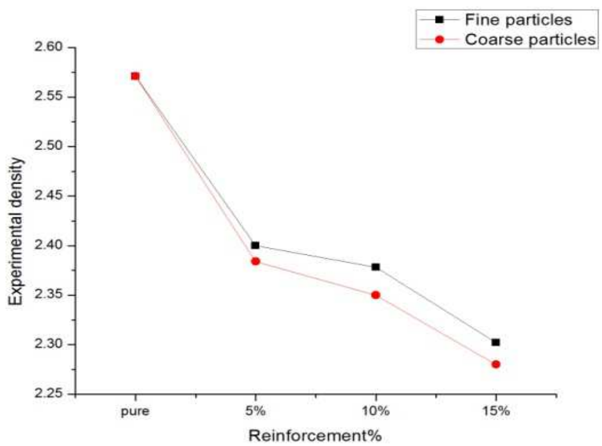


Figure 10: Showed the Experimental Density of the Metal Matrix Composite Materials.

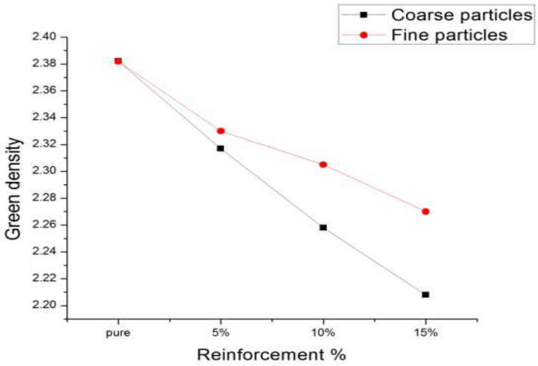


Figure 11: Showed the Green Density of the Metal Matrix Composite Materials.

C. Weight % of Boron Fiber Coarse Particles and Boron Fiber Fine Particles with Sintered Density

It is noted from figure 12 that increasing the compaction load increases the density of the compacts, because applying more load closes the gap between the particles and fills the boron fiber particles with matrix alloy. Increasing the boron fiber percentage decreases the density of the compacts; this is due to reduction of matrix content in the composites.

D. Weight % of Boron Fiber Coarse Particles and Boron Fiber Fine Particles with % of Void Content before Sintering Process

Void content % is higher in the case of composites fabricated using 5 ton load than the 12.5 ton loaded compacts, because lesser load is not sufficient to fill the voids completely. Figure 12 shows the graph between weight percent of boron fiber with percentage of void content. It can be noted from figure.13, percentage of void content increases with the increase of boron fiber content, this is because more addition of boron fiber makes more boron fiber fine content to be present in the compacts.

E. Weight %of Boron Fiber Coarse Particles and Boron Fiber Fine Particles with % of Void Content after Sintering Process

From figure 11 and figure 12, it is inferred that the sintering process decreased the percentage of void content in both 5 ton and 12.5 ton loads. During sintering process, atomic bonding is occurring between the particles, this action causes to close some percentage of void content in the compacts.

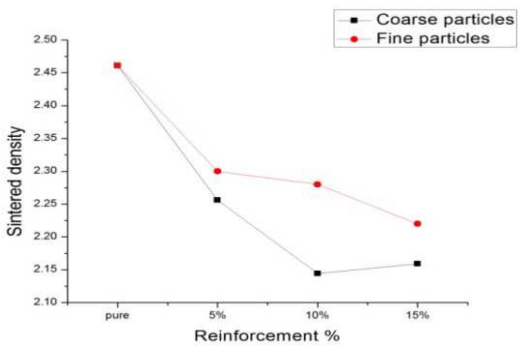


Figure 12: Showed the Sintered Density of the Metal Matrix Composite Materials.

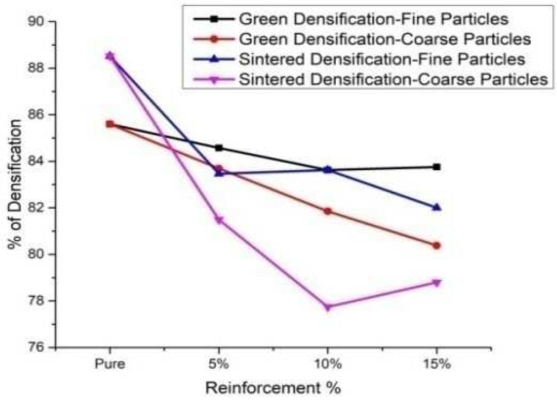


Figure 13. Showed the % Densification of the Metal Matrix Composite Materials.

3.3 Compacting and Sintering

The particulate reinforcement of boron fiber (Coarse and fine) material expands the density during compacting and sintering. Build up occurs during the treating the soil procedure and the particles close to each other by growing the crushing power, while during the sintering system in light of warm welding between the particles, and subsequently forming the necking between them, which accordingly causes the shrinkage of the sintered examples, and therefore lead to improve the density which addresses a noteworthy of physical property (Kailasanathan et al., 2015). At the same time, the temperature of sintering strategy made a solid bonding between the particulate reinforced materials and the matrix, which affected on properties of mechanical, for instance, yield, extreme elasticity and hardness by virtue of the dispersing of particulate reinforcement materials in the matrix, which causes a higher thickness of division and make withdrawal hover around reinforcement particles, keeping them from any development between them (Sun et al., 2011). When all said is done, the density of metal matrix composite(MMC's) materials decreases with expanding the volume portion of the added substance nano particles; it is credited to that the diminishing of the weight capacity with expanding the volume division of boron fiber coarse particles and boron fiber, fine particles and simultaneously shaping the pores at the interfaces between boron fiber particles and the matrix of AL2024 alloy, the density with boron fiber fine particles more than for boron fiber coarse particles, and furthermore higher than in the aluminum matrix. Figure.9 and figure 10 demonstrates that clearly.

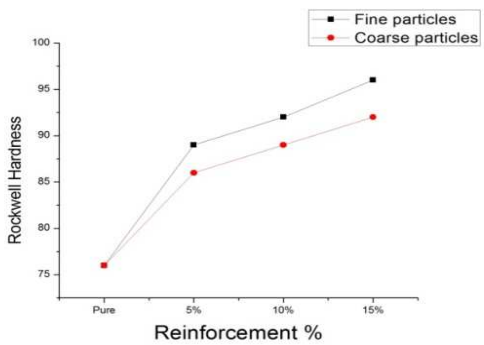


Figure 14: Showed the Hardness Forming of the Metal Matrix Composite Materials.

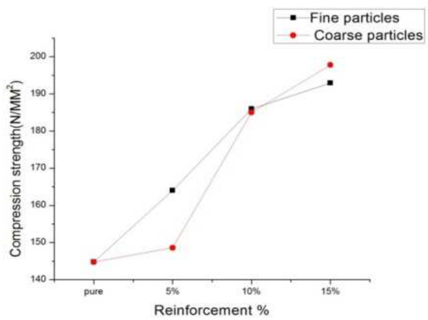


Figure 15: Showed the Compression Strength of the Metal Matrix Composite Materials.

3.4 Effect of Boron Fiber Coarse Particles and Boron Fiber Fine Particles on the Hardness of MMC's Material

The properties of the particulate reinforcement material and the size of the added substance particles expand the Volume of boron fiber coarse particles, boron fiber and fine particles. The hardness of composite material with boron fiber fine particles is higher. For composite material with boron fiber coarse particles, it has come back to that the boron fiber, fine particles were made strong bonding with aluminum matrix higher than for boron fiber coarse particles, and additionally the particles of boron fiber, fine particles avert the disengagements and pining them at their destinations, and afterwards expand the hardness of the produced composite material. This outcome concurred with that of (Jeevan, et al., 2012). Figure 14 demonstrates that expanding the volume portion of boron fiber, fine particles and boron fiber coarse particles prompt increment in the hardness.

3.5 Effect of Boron Fiber Coarse Particles and Boron Fiber Fine Particles on the Compressive Strength of MMC's Material

The Effect of Boron fiber coarse particles and boron fiber fine particles on the Compressive Strength of MMC's material is subjected to the volume portion of the added substance particles and their sizes. Expanding the level of boron fiber, fine particles and boron fiber coarse particles prompts increment the yield and compressive strength; it is credited to that the response among particles and the matrix which made warm anxieties due to the contrasts between the liquefying purposes of boron fiber fine particles and boron fiber coarse particles. The strengthened particles disengagement to move to start with one molecule, then onto the next, and after that builds the yield quality and compressive strength. Figure 15 demonstrates that the expansion of volume division of boron fiber, fine particles and boron fiber fine particles increases the compressive strength. Boron fiber, fine particles increment the compressive strength more than boron fiber, fine particles for similar reasons referenced already. The after effect of this test is concurred with (Shorowordi et al., 2003).

4. CONCLUSIONS

- Expanding the volume portions of boron fiber, fine particles and boron fiber coarse particles for Aluminum composite matrix prompts to improve the mechanical properties, for example, hardness and compressive strength.
- Expanding the volume portions of boron fiber, fine particles and boron fiber coarse particles for Aluminum composite matrix prompts to improve the Physical properties, for example, theoretical density and experimental density.
- Little volume portions of boron fiber, fine particles and boron fiber, fine particles were agglomerated in Aluminum composite matrix, while expanding the volume divisions of boron fiber, fine particles and boron fiber, fine particles were dispersed homogeneously in AL2024 matrix, and lean toward the level of boron fiber fine particles is (10%).
- Improving the mechanical properties and physical properties for boron fiber fine particles more than for boron fiber coarse particles.
- Green Densification of fine particles of the composite decreasing up to 10% composition, further increasing to 15% of the compositions.
- Green Densification of coarse particles of the composite decreasing up to 15% composition, Sintered Densification of fine particles and coarse particles of the composite decreasing up to 5% composition, further fine

particles increasing to 10%, and finally decreasing to15% of the compositions.

- Sintered Densification of coarse particles of the composite decreasing up to 10% composition, further increasing to 15% of the compositions.
- Aluminium alloys, boron fiber fine particles boron fiber fine particles composites can be successfully fabricated by Powder Metallurgy Technique.
- Addition of boron fiber fine particles boron fiber fine particles increases the compressibility behavior of aluminum alloys. Compaction load is having significant effect on density of fabricated composite.
- Theoretical density of the composites specimens decreases with the increasing percentage of boron fiber fine particles and boron fiber coarse particles.
- Increasing the percentage of boron fiber fine particles and boron fiber coarse particles creates more voids in the fabricated composites, thus results decrease in green density. Sintered samples show the improved density, this is due to void closer during sintering, Finally, addition of boron fiber fine particles boron fiber coarse particles in to the aluminum alloy promotes void content percentage and decreases the green density, sintered density.

REFRENCES

1. *Zhenga, R., Chena, J., Zhanga, Y., and Mab, K. A. (2014). Fabrication and characterization of hybrid structured Al alloy matrix composites reinforced by high volume fraction of B_4C particles, ELSEUIER, Materials Science and Engineering Al6061, pp20–28.*
2. *Muthukrishnan, N., and Murugan, M., Rao, K. P., (2008). Mach inability issue in turning Al-SiC (10%) metal matrix Composites, International Journal of advanced manufacturing technology, Vol.17, No.3, pp. 1220–1228*
3. *Khairaldien, W. M., Khalil, A. A., and Bayoumi, M. R., (2007). Production of Aluminum-Silicon Carbide Composites using Powder Metallurgy at sintering temperature above the aluminum melting point, Journal of testing and evaluation, Vol. 35, No.6, pp. 111–125.*
4. *Ahmed, A. R., Asokan, P., and Aravindan, S. (2009). EDM of hybrid Al-SiCP–GlassP MMCS, International Journal of advanced manufacturing technology, Vol.44, No.5, pp.520–528.*
5. *Attar, S., Nagaral, M., Reddapa, H. N., and Auradi, V. (2015). A review on particulate reinforced aluminum metal matrix Composites, Journal of Emerging Technologies and Innovative research (JETIR), Vol. 2, Issue, pp.225–229.*
6. *Nazik, C., Tarakcioglu, N., Ozkaya, S., Erdemir, F., and Canakci, A. (2016). Determination of effect of B_4C content on Density and Tensile Strength of AA 7075/ B_4C Composite produced via Powder Technology, International Journal of Materials, Mechanics and Manufacturing, Vol.4, No.4, pp.251–254.*
7. *Suryanarayana C. Mechanical alloying and milling. Prog Mater Sci2001; 46:1–184.*
8. *Erich DL. Metal-matrix composites: problems, applications, and potential in the P/M industry. Prog Powder Metal (1986); 46:45–65.*
9. *Ekiki, R., Apalak, M. K., Yildirim, M., and Nair, F., (2010). Effect of random particle dispersion and size on the indentation behavior of SiC particle reinforced metal matrix composites, Materials and Design, Vol. 31, pp. 2818–2833.*
10. *Nagard, M., Bharath, V. and Auradi, V., (2013). Effect of Al_2O_3 particles on mechanical and wear properties of 6061 Al alloy metal matrix composites, Journal of Material science and Engineering, Vol. 2, No. 1, pp. 120–128. Number 10 Volume 23*

October 2017 Journal of Engineering

11. *Y. S. Kwon et.al., Solid-State Sintering of Metal Powder Mixtures‖ Journal of Materials Synthesis and Processing November (2001), Volume 9, Issue 6, pp. 299–317*
12. *W.-F. Wang et.al., Effect of Powder Type and Compaction Pressure on the Density, Hardness and Oxidation Resistance of Sintered and Steam Treated Steels‖ Journal of Materials Engineering Performance, Vol. 16, No. 5,(2007), pp. 533–538.*
13. *Callister, W. D., and JR., (2003). Material Science and Engineering, An Introduction, John Wiely and Sons Inc., New York.*
14. *Venkatesh, B., and Harish, B., (2015). Mechanical Properties of Metal Matrix Composites (Al SiCP) particles produced by Powder Metallurgy, International Journal of Engineering Research and General Science, Vol.3, Issue, pp. 1277–1284.*
15. *Jain, S., Rana, R. S., and Jain, P., 2016, Study of Microstructure and Mechanical Properties of Al-Cu matrix reinforced with B4C particles Composite, International Research Journal of Engineering and Technology (IRJET), Vol.3, Issue. 1, pp 499–504.*
16. *Siddhartha Tiwari et.al., Densification Behavior in the Fabrication of Al-Fe Metal Matrix Composite using Powder Metallurgy Route‖ ISRN Metallurgy Volume 2012, pp. 1–8.*
17. *P. K. Rohatgi Prasanta et. al.,Compressive characteristics of A356/fly ash cenosphere composites synthesized by pressure infiltration technique‖ Composites: Part A 37 (2006) pp. 430–437.*
18. *El-Bagoury, N. H., Omar, A. A., & EL-Masry, A. L. I. A. Effect of Semi-Solid Process on Microstructure and Mechanical Properties of Medium Carbon Steel Produced by Continuous Casting.*
19. *C. Kailasanathan, G. Chandrasekar, Balasubramaniam Nidhushan, K. Chenniyappan, V. Boomiraj analysis of green density, sintered density and void content percentage of az91 d magnesium alloy- fly ash composites fabricated using powder metallurgy route international journal of applied engineering research, issn 0973–4562 vol. 10 no.39 (2015).*
20. *Sun, C., Song, M., Wang, Z., and He, Y, (2011). Effect of Particle Size on the Microstructures and Mechanical Properties of SiC-Reinforced Pure Aluminum Composites, Journal of Materials Engineering and Performance. 20(9) 1606–1612.*
21. *Jeevan, V., Rao, C. S., and Selvaraj, N., (2012). Compaction, sintering and mechanical properties of Al-SiCp composites, International Journal of mechanical engineering and technology (IJMET), Vol.3, Issue.3, pp. 565–573.*
22. *Davangeri, M. B., Vinay, B. U., & Bhat, V. (2014). Development and Evaluation of Mechanical Properties of Asbestos Filled E-Glass/Epoxy Composites. Development, 4(1), 25–30.*
23. *Shorowordi, H. A., Laoui, T., Haseeb, A. S., Celis, I. P., and Froyen, L., (2003). Microstructure and interface characteristics of B_4C, SiC and Al_2O_3 reinforced Al matrix composites: a comparative study, Journal of materials processing technology, Vol.14, pp.738–743.*

AUTHORS PROFILES

R. RAMANJANEYULU, Research Scholar, Department of Mechanical Engineering, JNTUA, Ananthapuramu, Andhra Pradesh -515002, India, Qualification: M.Tech, Experience: Teaching: 10 Years and Research: 2 Years, Publication's: International Journals is 06 and International Conferences is 01, Research work: Composite materials.

Dr. K.RAJA GOPAL, Professors, Department of Mechanical Engineering, KSRMCE (Autonomous), Kadapa, Andhra Pradesh-516003, India, Qualification: B.Tech, M.Tech, Ph.D, Experience: Teaching: 30 Years and Research: 04 Years Publication's : International Journals is 10, national Journals is 30 and Conferences is 10, Research work: Operation Research, Membership : Fellow in institutional of engineers, Achievements : Best paper awards in 1997 and 1998

Dr. B. DURGA PRASAD, Professors, Department of Mechanical Engineering, JNTUA Ananthapuramu, Andhra, Pradesh -515002, India. Qualification: M.Tech, Ph.D, Experience: Teaching: 25 Years and Research: 16 Years, Publication's : International Journals is 70 and International Conferences is 30, Research work: Internal Combustion Engines, Thermal Engineering.